USB 3.0 ENGINEERING CHANGE NOTICE

ECN #012

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Title: USB3.0 Reference Equalizer
Applied to: USB3_r1.0_06_06_2011

Brief description of the functional changes proposed:

Section 6.8.2 contains a reference transfer function for the receive-side equalizer (informative spec). This reference equalizer function is tailored to a long channel (3m cable plus long host PCB trace, ~18-20dB differential insertion loss). Due to concerns raised about ensuring proper equalizer behavior in a short channel (no cable and short host PCB, ~3-5dB differential insertion loss), it is proposed to add a second informative reference equalizer transfer function that is optimized for the short channel.

Benefits as a result of the proposed changes:

The change provides additional guidance to PHY layer designers for making sure that they include sufficient dynamic range in their equalizer designs. The added reference transfer function will also be used for electrical compliance testing with a low loss channel. Both of these uses of the transfer function address the short channel concern and therefore minimize the opportunity for a design to enter the market which fails to work properly in a low loss channel environment.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

Samples of all known PHY designs on the market have been tested with the short channel and equivalent reference transfer function and met spec compliance requirements. All met the compliance requirements.

An analysis of the hardware implications:

Increases the confidence that any new host/hub/device PHY designs will successfully interoperate.

An analysis of the software implications:

None.

An analysis of the compliance testing implications:

This change enables planned additions to the electrical compliance testing for transmitters and receivers. The specific added tests are SuperSpeed transmitted eye (TD.1.3) and receiver jitter tolerance (TD.1.5) compliance tests with a short (minimum insertion loss) channel.

Actual Change Requested

(a). From Text (and location): Section 6.2.1, Page 6-4

The normative SuperSpeed eye diagram is to be measured through a compliance channel that represents the sum of a long channel, a short channel, and a 3-meter cable. This requires three separate tests for compliance. These reference channels are described in the *USB SuperSpeed Compliance Methodology* white paper. The eye diagram is measured using the clock recovery function described in Section **Error! Reference source not found.**.

For the long channel case the eye diagram at the receiver is completely closed. An informative receiver equalization function is provided in Section **Error! Reference source not found.** that is optimized to the compliance channel and is used to open the receiver eye.

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To Text (and location): Section 6.2.1, Page 6-4

The normative SuperSpeed eye diagram is to be measured through compliance channels that represent long and short channel in order to cover the range of losses seen by real applications. These reference channels are described in the *USB 3.0 SuperSpeed Equalizer Design Guidelines* white paper. The eye diagram is measured using the clock recovery function described in Section **Error! Reference source not found.**.

Due to non-ideal channel characteristics, the eye diagram at the receiver may be completely closed. Informative receiver equalization functions are provided in Section **Error! Reference source not found.** that are optimized for the compliance channels and are used to open the receiver eye.

(a). From Text (and location): Section 6.8.2, Page 6-25, Figure 6-17

The equation for the continuous time linear equalizer (CTLE) used to develop the specification is the compliance Rx EQ transfer function described below.

(10) $$H(s) = \frac{A_{dc}\omega_{p1}\omega_{p2}}{\omega_z} \cdot \frac{s+\omega_z}{(s+\omega_{p1})(s+\omega_{p2})}$$

(11) $$A_{dc} = 0.667$$
$$\omega_z = 2\pi\left(650x10^6\right)$$
$$\omega_{p1} = 2\pi\left(1.95x10^9\right)$$
$$\omega_{p2} = 2\pi\left(5x10^9\right)$$

Error! Reference source not found. is a plot of the Compliance EQ transfer function.

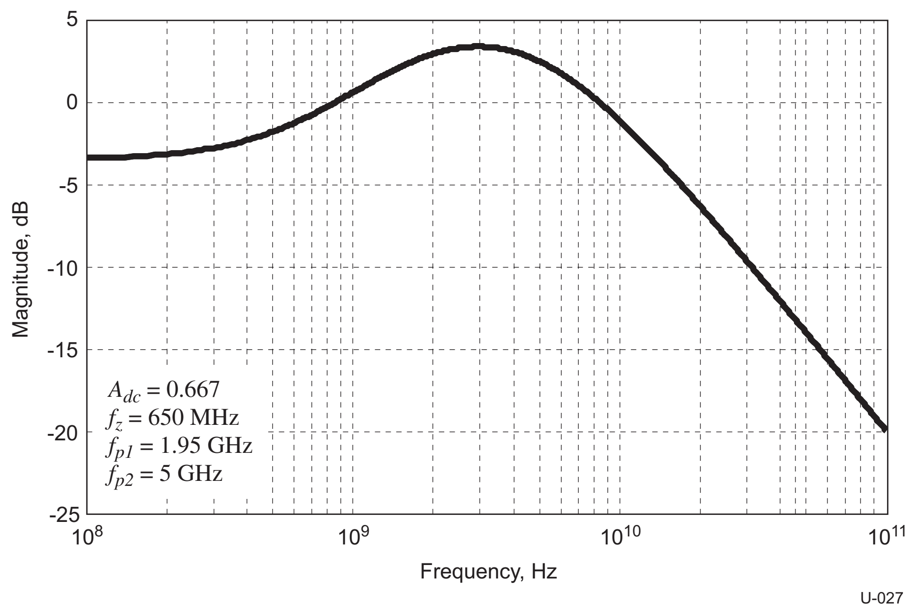

Figure Error! No text of specified style in document.**-1. Tx Compliance Rx EQ Transfer Function**

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To Text (and location): Section 6.8.2, Page 6-25, Figure 6-17

The equation for the continuous time linear equalizer (CTLE) used to develop the specification is the compliance Rx EQ transfer function described below.

(10) $$H(s) = \frac{A_{dc}\omega_{p1}\omega_{p2}}{\omega_z} \cdot \frac{s+\omega_z}{(s+\omega_{p1})(s+\omega_{p2})}$$

where A_{dc} is the DC gain

$\omega_z = 2\pi f_z$ is the zero frequency

$\omega_{p1} = 2\pi f_{p1}$ is the first pole frequency

$\omega_{p2} = 2\pi f_{p2}$ is the second pole frequency

Error! Reference source not found. is a plot of the Compliance EQ transfer functions with the values for each of the input parameters.

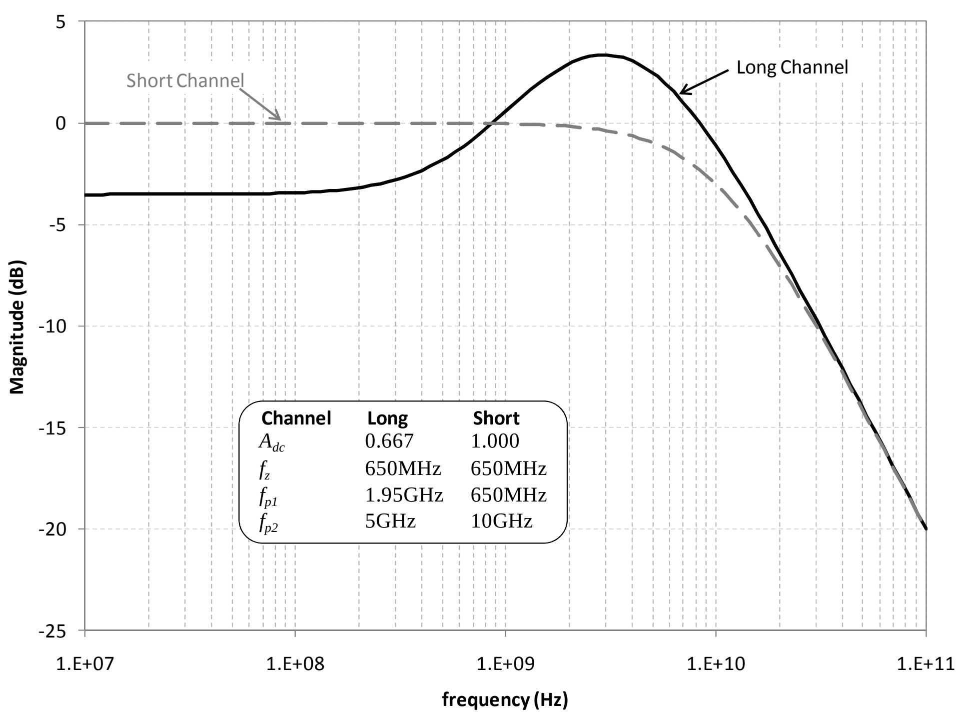

Figure Error! No text of specified style in document.**-2. Tx Compliance Rx EQ Transfer Functions**